Consumer Color and Discoloration Thresholds for Purchase of Retail Ground Beef When Evaluating Packages of a Single Day of Display

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Abstract

This study utilized a simulated retail display to investigate the impact of ground beef color and discoloration on consumer purchase intent, while identifying the best objective measurements to predict consumer preferences of ground beef on the same day of retail display. Ground beef loaves (80% lean/20% fat) were obtained and assigned to a specific day of retail display (day 0–9). Consumers (n = 318) assessed ground beef samples at each day of display, with a single day of display evaluated per consumer group. Results of these models showed that the objective measurements assessed were indicators ($P < 0.05$) of consumer purchase intent. Logistic regression equations which predicted consumer purchase intent were significant ($P < 0.01$) for all objective measures and had R^2 values of 0.26–0.65. The logistic regression models accurately classified 70.5–84.0% of samples as would/would not purchase. Linear regression equations that predicted consumer overall liking of appearance scores were significant ($P < 0.01$), with R^2 values of 0.35–0.54. The a^* (redness) values of 20.7, 26.2, 31.7, and 35.4 correspond with consumers being 50, 75, 90, and 95% likely to purchase the product at full price. However, if the product was discounted, the values were 17.7, 22.7, 27.7, and 31.1. The percentage of metmyoglobin values of 37.8, 28.7, 19.5, and 13.3 correspond with consumers being 50, 75, 90, and 95% likely to purchase the product at full price and 45.2, 36.0, 26.9, and 20.6 if the product was discounted. Overall, these models showed that each of the objective measures evaluated were predictors of consumer purchasing intent and can be utilized by ground beef producers to predict consumer purchasing behaviors and willingness to purchase.

Introduction

The consumer discrimination of ground beef results in 2.55% of beef being discarded at the retail level, which is equivalent to 780,000 head of cattle going to waste in the United States alone (Ramanathan, 2022). Consumers often use discoloration as an indicator of meat freshness and wholesomeness when making meat purchasing decisions (Mancini and Hunt, 2005), but knowledge surrounding consumer perceptions of meat color is limited. Therefore, the objective of this study was to investigate the impact

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of ground beef color and discoloration on consumer purchase intent, while identifying the best objective measures to predict consumer preferences of ground beef on the same day of retail display.

Experimental Procedures

A commercial processor provided 180 1-lb 80% lean ground beef loaves for this study. Each loaf was assigned to a specific day of retail display (day 0–9) and placed under fluorescent lights in coffin-style cooler cases. Consumers (n = 318) assessed ground beef samples at each day of display, with a single day of display evaluated per consumer group. Consumers used 100-point continuous line scales to indicate overall appearance for each sample and indicated their willingness to purchase the loaves at full price and discounted prices with yes/no questions. A trained descriptive panel assessed redness and percentage discoloration values. A HunterLab Miniscan spectrophotometer (Model 2500L, Hunter Associates Laboratory Inc, Reston, VA) collected L^* (lightness), a^* (redness), and b^* (yellowness) values and hue angle, chroma, percent oxymyoglobin and percent metmyoglobin were calculated. Simple linear regressions were calculated for consumer overall appearance ratings, while logistic regression models were calculated for the probability of each sample being classified as "would purchase" for full and discounted price responses from consumers. Lastly, Pearson correlation coefficients were calculated for relationships among sensory and objective measurements.

Results and Discussion

Results of these models showed that the objective measurements assessed were indicators of consumer purchase intent. Logistic regression equations that predicted consumer purchase intent were significant ($P < 0.01$) for all objective measures and had R^2 values of 0.26–0.65. The logistic regression models accurately classified 70.5–84.0% of samples as would/would not purchase. Linear regression equations that predicted consumer overall liking of appearance scores were also significant ($P < 0.01$), with R^2 values of 0.35–0.54. Calculated Pearson correlation coefficients were significant ($P < 0.01$) among all variables with r values of 0.10–0.99. Threshold values for consumer willingness to purchase for a^* were 20.7, 26.2, 31.7 and 35.4, which aligned with consumers being 50, 75, 90 and 95% likely to purchase the ground beef at full price (Figures 1 and 2); whereas packages sold at a discounted price saw reduced a^* values to 17.7, 22.7, 27.7, and 31.1, respectively (Table 1). Notably, thresholds for calculated percentage metmyoglobin were 37.8, 28.7, 19.5, and 13.3, which coincided with consumers being 50, 75, 90, and 95% likely to purchase ground beef at full price (Figures 3 and 4). These scores shifted to 45.2, 36.0, 26.9, and 20.6 for discounted packages, indicating consumer willingness to purchase ground beef with greater discoloration when offered at a lower price (Table 1).

Implications

Consumer intent to purchase ground beef at varying days of retail display can be predicted by the objective measures used in this study. Several measures including a^* and calculated percentage metmyoglobin were good predictors of consumer likelihood to purchase. Moving forward, these models can provide ground beef producers and retailers with an indication of potential consumer purchasing behaviors for ground beef at varying levels of discoloration.

Acknowledgments

References
Mancini, R. A., and M. C. Hunt. 2005. Current Research in Meat Color. Meat Sci. 71:100-121. doi:10.1016/j.meatsci.2005.03.003.

Ramanathan, R., Lambert, L. H., Mahesh, N. N., Morgan, B., Feuz, R. Mafi, G., and Pfeiffer, M. 2022. Economic Loss, Amount of Beef Discarded, Natural Resources Wastage, and Environmental Impact Due to Beef Discoloration. Meat Muscle Biol. 6. doi:10.22175/mmb.13218.

Table 1. The 50, 75, 90, and 95% likeliness thresholds for various objective quality measures for consumer purchase intent of 80% lean/20% fat ground beef

Measurement	50%	75%	90%	95%
Product sold at full price				
L^*	52.2	54.7	57.3	59.0
a^*	20.7	26.2	31.7	35.4
b^*	20.2	22.8	25.3	27.1
Metmyoglobin[1]	37.8	28.7	19.5	13.3
Oxymyoglobin[1]	57.9	67.9	77.9	84.7
Chroma[1]	29.7	35.5	41.3	45.2
Hue angle[1]	0.79	0.72	0.66	0.61
Trained sensory panel redness score[2]	60.6	82.6	-	-
Trained sensory panel discoloration score[3]	40.3	12.8	-	-
Consumer appearance score[4]	48.4	60.7	72.9	81.2
Product sold at discounted price				
L^*	50.0	52.5	55.1	56.8
a^*	17.7	22.7	27.7	31.1
b^*	19.1	21.4	23.7	25.3
Metmyoglobin[1]	45.2	36.0	26.9	20.6
Oxymyoglobin[1]	48.8	57.9	67.1	73.3
Chroma[1]	25.8	30.8	35.8	39.2
Hue angle[1]	0.84	0.77	0.70	0.66
Trained sensory panel redness score[2]	45.6	67.6	89.6	---
Trained sensory panel discoloration score[3]	79.0	42.4	5.8	---
Consumer appearance score[4]	38.8	51.0	63.2	71.5

[1]Calculated utilizing the equations presented in the AMSA Meat Color Measurement Guidelines (AMSA, 2012).
[2]Sensory scores: 0 = extremely dark red, 100 = bright cherry red.
[3]Sensory scores: 0 = no visible discoloration, 100 = complete discoloration.
[4]Sensory scores: 0 = extremely undesirable, 100 = extremely desirable.
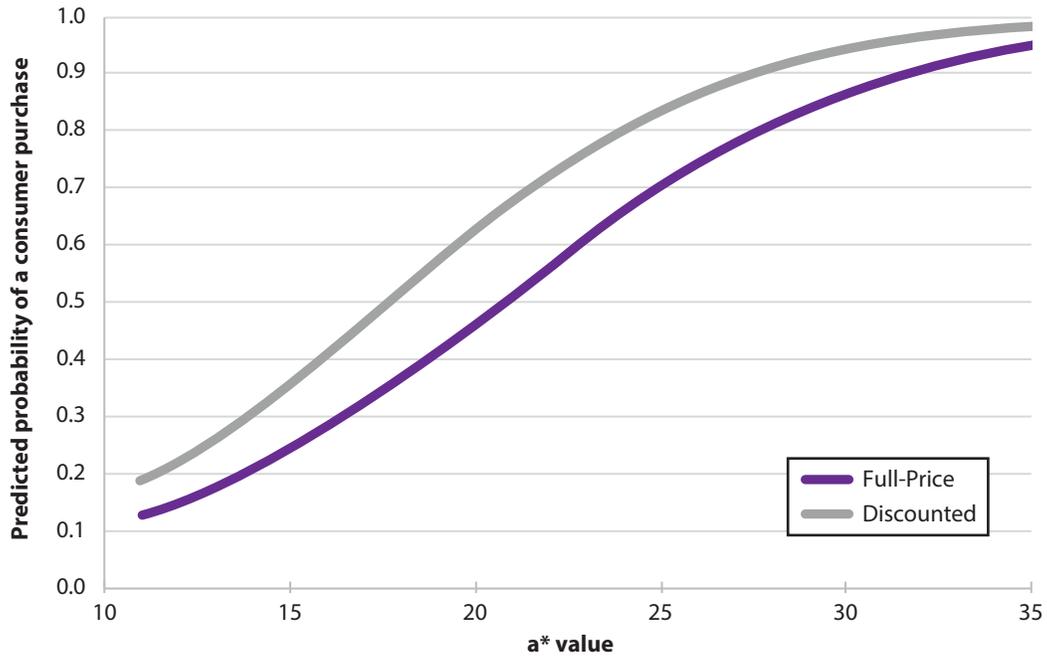L^* (lightness), a^* (redness), and b^* (yellowness).

Figure 1. Probability of a consumer purchasing an 80% lean/20% fat ground beef package based on _a_* (redness) value and pricing.
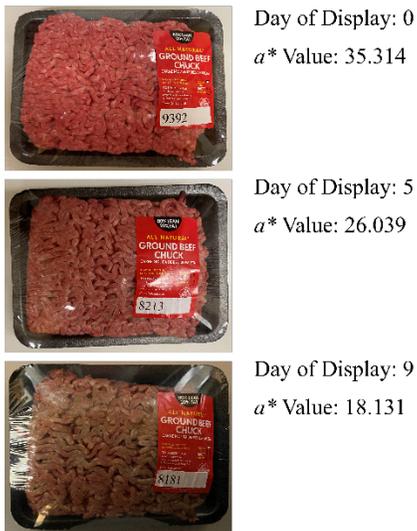

Day of Display: 0
_a_* Value: 35.314

Day of Display: 5
_a_* Value: 26.039

Day of Display: 9
_a_* Value: 18.131

Figure 2. Sample photos with corresponding _a_* (redness) values.
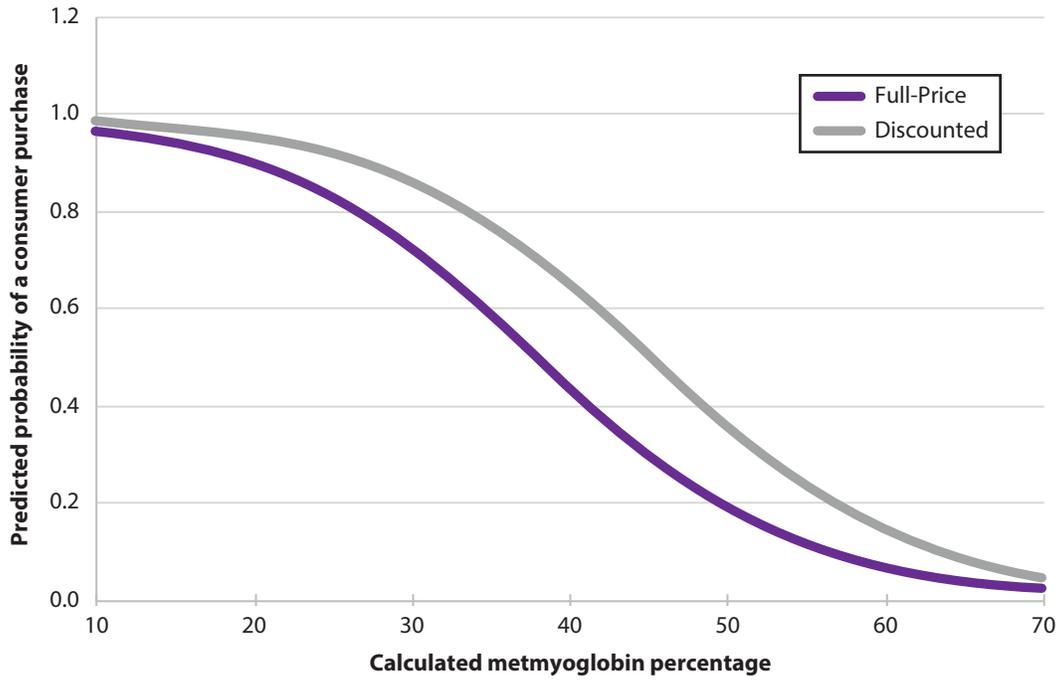
Figure 3. Probability of a consumer purchasing an 80% lean/20% fat ground beef package based on calculated metmyoglobin percentage and pricing.

Day of Display: 0

Calculated Percentage
Metmyoglobin: 20.78

Day of Display: 5

Calculated Percentage
Metmyoglobin: 27.03

Day of Display: 9

Calculated Percentage
Metmyoglobin: 48.28

Figure 4. Sample photos with corresponding calculated percentage metmyoglobin values.